Golder Associates
18300 NE Union Hill Road, Suite 200
Redmond, WA 98052-3333
Telephone (425) 883-0777
Fax (425) 882-5498

TRANSMITTAL LETTER

TO: Monsanto
PO Box 816
Soda Springs, Idaho 83276

Attention: Bob Geddes

DATE: October 6, 2006

PROJECT NO.: 913-1101.605

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QUANTITY	ITEM	DESCRIPTION
As noted	Bound Documents	MONSANTO SODA SPRINGS PLANT – GEOPHYSICAL SURVEY SOUTH OF PLANT SITE TO LOCATE NEW MONITORING WELLS Dated: October 6, 2006
REMARKS:		

Per: David Banton / Peter Fahringer / Matthew Benson

Bob Geddes (2 copies)
Monsanto Chemical Company
PO Box 816
Soda Springs, Idaho 83276

Wally Reid (1 copy)
US EPA, Region X
1200 Sixth Avenue
Seattle, Washington 98101

Doug Tanner
DEQ Pocatello Regional Office
444 Hospital Way #300
Pocatello, Idaho 83201

Bill Wright (1 Copy)
Montgomery Watson
2375 130th Avenue NE, Suite 200
Bellevue, Washington 98005-1758

Internal: David Banton/Michael Klisch

Golder Associates Inc.
18300 NE Union Hill Road, Suite 200
Redmond, Washington 98052
Telephone: (425) 883 0777
Fax: (425) 882 5498

Golder Associates

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IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY

TECHNICAL MEMORANDUM

TO: Bob Geddes, Monsanto **DATE:** October 6, 2006

FR: Peter Fahringer and Matthew Benson **OUR REF:** 913-1101-605

Reviewed by: David Banton

RE: MONSANTO SODA SPRINGS PLANT - GEOPHYSICAL SURVEY SOUTH OF PLANT SITE TO LOCATE NEW MONITORING WELLS

This memorandum summarizes the results from the August 2006 geophysical investigation conducted by Golder Associates Inc. (Golder) south of the Monsanto Soda Springs Plant (Plant), Soda Springs, Idaho. The geophysical investigation consisted of electrical resistivity imaging (ERI) along four linear transects (lines) south of the Plant boundary to assist in the selection of locations for additional groundwater monitoring wells. The work was carried out between August 9 and August 15, 2006.

The geophysical survey is described in the Work Plan that was submitted to Monsanto (dated August 3, 2006) (Golder, 2006b). The objectives of the survey as described in the Work Plan are as follows:

- To evaluate the subsurface geological conditions;
- To map zones of elevated groundwater conductivity; and
- To provide recommended monitoring well locations based on the geophysical results.

1.0 ELECTRICAL RESISTIVITY IMAGING (ERI) METHODOLOGY AND FIELD PROGRAM

The ERI method detects differences in the electrical resistivity of geologic materials. These differences can result from variations in lithology, water content, pore-water chemistry, or groundwater quality. Like conventional direct current resistivity surveys, this method involves transmitting an electric current into the ground between two current electrodes and measuring the voltage between two separate potential electrodes. The measured point, called a sounding, represents the apparent resistance of the area beneath the electrodes. Software controlling the resistivity meter utilizes multiple electrode arrangements to collect enough soundings to produce an apparent resistivity profile below the ERI survey transects with one field step up.

ERI data were recorded using an AGI SuperSting resistivity meter. The internal transmitter, powered by an external deep-cycle marine battery, was used to provide the source current. The resistivity meter was programmed to record measurements using a dipole-dipole electrode configuration (array).

The array was constructed using 56 stainless steel electrodes with an electrode spacing of 6 meters (19.68 feet).

Various electrode spacings within the array were measured by the AGI SuperSting resistivity meter and data were stored electronically for later processing and interpretation. Stored data were downloaded from the console onto a field laptop computer at the end of each transect in order to perform quality control inspections of the field data and develop preliminary profiles prior to deconstruction of the array.

As outlined in Section 4.1 of the Work Plan for Drilling and Monitoring Well Installation, Monsanto Soda Springs Plant (Golder, 2006), four separate east-west trending ERI lines were surveyed (Figure 1).

- Line 1 was completed adjacent and parallel to the Southern Boundary Wells on the east side of Government Dam Road and is approximately 1,630 feet long.
- Line 2 was broken into two segments: a longer segment (Line2E), approximately 1,630 feet long, located approximately 1,000 feet south of Line 1 and east of Government Dam Road; and a shorter segment (Line 2W), approximately 810 feet long, west of the road.
- Line 3 was broken into two segments: a segment approximately 1,000 feet long (Line 3E), located approximately 1,000 feet south of Line 2 and east of Government Dam Road; and a segment west of the road (Line 3W), approximately 1,080 feet long, just south of Homestead Spring.
- Line 4 was broken into two segments: a segment approximately 1,080 feet long (Line 4E), located approximately 800 feet south of Line 3 and east of Government Dam Road; and a segment west of the road (Line 4W), approximately 530 feet long.

Table 1 presents the coordinates collected for endpoints of the ERI lines using a handheld GPS receiver and calculated line length. These lengths are different than the line lengths shown in Figures 2 and 3 because the length of the model is shorter than the actual line length and because of inaccuracies in the GPS survey.

Table 1

UTM Coordinates* for Endpoints of ERI Lines

Station	Northing (meters)	Easting (meters)	GPS Length meters (feet)
Line 1, Start (west)	4,724,917	451,356	503 (1,650)
Line 1, End (east)	4,724,910	451,859	
Line 2E, Start (west)	4,724,616	451,334	503.2 (1,651)
Line 2E, End (east)	4,724,551	451,833	
Line 2W, Start (west)	4,724,630	451,061	249.1 (817)
Line 2W, End (east)	4,724,622	451,310	
Line 3E, Start (west)	4,724,341	451,334	311.1 (1,021)
Line 3E, End (east)	4,724,334	451,645	
Line 3W, Start (west)	4,724,343	450,970	335 (1,099)
Line 3W, End (east)	4,724,346	451,305	
Line 4E, Start (west)	4,724,175	451,330	337.1 (1,106)
Line 4E, End (east)	4,724,168	451,667	
Line 4W, Start (west)	4,724,182	451,142	162.2 (532)
Line 4W, Start (west)	4,724,174	451,304	

*UTM coordinates and elevations collected using one minute averaging of a WAAS-enabled handheld GPS. WGS84 datum

2.0 DATA PROCESSING

ERI data were processed and modeled using a least-squares inversion using RES2DINV software, commercially available through Geotomo Software. The inversion process produces a resistivity profile of true resistivity with depth, based on a least-squares fit between observed data and model response. The modeled 2-dimensional resistivity profile generated is a color contoured cross-section highlighting variations in apparent subsurface resistivity. ERI data collected on the west side of Government Dam Road, where significant variations in surface topography exist, were corrected for topographic effects using surveyed elevation data during the computational analysis within RES2DINV.

3.0 INTERPRETATION AND RESULTS

The subsurface geology at ERI survey Line 1 is known from drilling records at monitoring wells TW-53, TW-54, TW-55 and TW-56. There is approximately 20 to 25 feet of unconsolidated material (silt and clay) overlying basalt. Within the basalt, there are thin zones (interflow zones about 4 to 20feet thick) of highly permeable weathered basalt (including cinders, sandy silt and silty sand). These interflow zones are the main zones of groundwater flow.

As shown in Table 2, groundwater along ERI Line 1 (in monitoring wells TW-53, TW-54, and TW-55) is found in the Upper Basalt Zone (UBZ) at a depth of 21.45 to 30.93 feet below ground surface (bgs) and increases to 59.20 feet bgs (at TW-56) just to the east of the end of Line 1 where the ground elevation increases. Groundwater total dissolved solids along ERI line 1 varies in from 688 mg/L at TW-56 just east of the line to 1,610 mg/L in TW-54 at approximately 930 feet along the line. The apparent center of the plume moving southward from the Monsanto site is thus near TW-54. Groundwater flow direction is to the south and elevated concentrations of constituents from the Monsanto site are found in groundwater in the interflow zones in the Upper Basalt Zone (Golder, 2006a).

Table 2

Well Information Along ERI Line 1

Monitoring Well	Depth to Competent Basalt (feet bgs)	Depth to Water (feet bgs, July 2006)	Screened Interval (feet bgs)	Total Dissolved Solids (mg/L, July 2006)
TW-53	19	21.45	19.54-34	1,100
TW-54	25	30.90	39.26-54.3	1,610
TW-55	22	30.93	53.5-69	1,270
TW-56	21	59.20	86.8-100.3	688

Because ERI detects differences in observed electrical resistivity due to variations in lithology, water content, pore-water chemistry, and/or groundwater quality, it is expected that areas of decreased resistivity (increased conductivity) could be one or a combination of the following: more fractured basalt, higher clay content, a greater percentage of pore water, or increased total dissolved solids. Groundwater TDS values were compared to observed electrical resistivity values near the screened interval of each well near Line 1 (Figure 2). There was limited correlation between existing geochemical data from these monitoring wells and the interpreted ERI data. Areas of anomalously low electrical resistivity (high conductivity) do exist within the data collected. These may be areas where groundwater is affected by the release of constituents from the Monsanto site.

Figures 2 and 3 present the results of the ERI geophysical survey as a series of resistivity profiles of true resistivity with depth, based on a least-squares fit between observed data and model response. Figure 2 presents the resistivity profiles for survey Lines 1, 2E, 3E, and 4E, spaced approximately 1000 feet apart, all east of Government Dam Road. Figure 3 presents the resistivity profiles for survey Lines 2W, 3W, and 4W, spaced approximately 1000 feet apart, all west of Government Dam Road.

The measured apparent resistivity in ERI lines 1 through 4 ranges from less than 20 ohm-meters to over 6,500 ohm-meters (Figures 2 and 3). Resistivity values are contoured at regular intervals. Values less than 80 ohm-meters are interpreted as representing either moist clay-rich soil or saturated, more fractured basalt. Areas with values greater than 250 ohm-meters are relatively high electrical resistivity areas interpreted as competent basalt bedrock at depth or dry, coarse-grained soil near the surface.

The highly resistive zones (>4,500 ohm meters) observed in the modeled apparent resistivity (Figure 2) near the surface between line distance 690 and 900 feet along Line 1 east of the road, and in the subsurface between 620 and 720 feet along Line 3 east of the road, are likely the result of poor ground contact of the electrodes with the relatively dry soil. Data in these areas is suspect, and unlikely to be indicative of lithological or geochemical conditions in the subsurface.

Resistivity values along Line 1 suggest a nearly continuous, high resistivity, competent basalt bedrock exists from approximately 15 to 70 feet bgs along the line except near station 1,100 feet. Lithologic data from monitoring wells TW-53 through TW-56 support the interpretation that this is slightly weathered to fresh basalt. Definitive evidence of the Monsanto Fault or Subsidiary Fault does not appear in the Line 1 ERI profile or in any other ERI lines.

Line 2E resistivity values also suggest a nearly continuous competent basalt bedrock from approximately 20 to 50 feet bgs along the line except at station 1,090 feet where a more conductive feature is noted. Line 2W (west of Government Dam Road) resistivity values suggest a 10 to 20 foot thickness of low resistivity, moist, clay-rich material overlies higher resistivity basalt. The basalt may be more fractured below 25 feet bgs from station 420 to 500 feet.

Line 3E resistivity values suggest competent basalt exists from 10 to 15 feet bgs to over 100 feet bgs along the line with a potentially more conductive feature between stations 500 to 580 feet along the line. West of Government Dam Road, along Line 3W, the resistivity profile with depth is similar to Line 2W suggesting a 10 to 20 foot thickness of low resistivity, moist, clay-rich material overlies higher resistivity, basalt. A shallow higher conductivity feature possibly indicative of more fractured basalt is observed between station 720 and 950 feet along Line 3W.

The resistivity profile of Line 4E shows a distinct change in resistivity with depth between the west side of the line (0 to 540 feet) and the east side of the line (540 to 980 feet). The west of the line is similar to Lines 1, 2E, and 3E showing a continuous, high resistivity layer from 10 to 50 feet. East of 540 feet along Line 4E, a high resistivity layer does not appear in the profile until approximately 70 feet bgs. The geological interpretation of these data is uncertain; it could represent the dip of the basalt interflow zones to the south, or a thicker sequence of unconsolidated materials along the east side of Line 4E. West of Government Dam Road, the Line 4W resistivity profile suggests a moderate to high resistivity basalt flow layer exists below 20 feet bgs throughout the line.

4.0 CONCLUSION AND RECOMMENDATIONS

The effectiveness of the ERI method to delineate and map the area of affected groundwater from the Monsanto site was limited due to a combination of the subsurface geology and groundwater quality. Observed variations in electrical resistivity are interpreted to represent the complex resistivity characteristics associated with the subsurface geology and geochemical makeup of the pore fluids at this site. There was limited correlation between existing borehole lithologic and groundwater quality data and the interpreted ERI data, therefore the geophysical data can only provide a potential indication of sites that should be investigated further rather than delineating the area of affected groundwater. Areas of elevated conductivity (low resistivity) were measured during the survey. These locations could be zones of preferential groundwater flow from the Monsanto site, but may also be indicative of thicker sequences of clayey unconsolidated materials.

Four locations have been identified as sites for additional monitoring wells. The location of each of these potential wells is shown on Figures 1, 2 and 3, and the coordinates for each location are shown in Table 3.

Table 3

Coordinates of Recommended Monitoring Well Locations**

Location ID	Northing (meters)	Easting (meters)	Estimated Well Depth (feet)
A	4,724,628	451,250	45
B	4,724,573	451,663	60
C	4,724,337	451,490	50
D	4,724,170	451,544	50

** UTM coordinates, WGS84 datum.

Location A is recommended for the installation of a monitoring well because of the low apparent resistivity observed in this area along Line 2W.

Location B is recommended for the installation of a monitoring well because of the low apparent resistivity observed in this area along Line 2E. This area appears to be where the basalt flows observed in TW-53 through TW-56 could be more fractured.

Location C is recommended for the installation of a monitoring well because of the low resistivity between 720 and 950 feet along Line 3W. This location may be where the basalt may be more fractured.

Location D is recommended for the installation of a monitoring well because of the low apparent resistivity observed across the eastern portion of Line 4E and the increased depth of low resistivity at this location.

Monitoring well installation will proceed as discussed in Section 4.2 of the Work Plan for Drilling and Monitoring Well Installation, Monsanto Soda Springs Plant (Golder 2006b) following applicable rules and procedures.

After the new monitoring wells have been installed, the geologic data, groundwater elevations, and groundwater quality data will be interpreted and used to determine the nature and extent of constituents of interest south of Monsanto Plant site. The geologic and groundwater quality data will also be used to re-interpret the geophysical survey and to determine if additional wells are needed to delineate the extent of constituents of interest south of the Monsanto Plant site.

5.0 LIMITATIONS OF GEOPHYSICS

Golder's services are conducted in a manner consistent with that level of care and skill ordinarily exercised by other members of the geophysical community currently practicing under similar conditions subject to the time limits, and financial and physical constraints applicable to the services. Electrical resistivity imaging is a remote sensing method that may not detect all targets and interfaces of interest. It is also possible that the interpreted geophysical data may present subsurface geologic horizons that may be misinterpreted as geologic boundaries.

6.0 REFERENCES

Golder 2006a, 2005 Summary Report, Groundwater Conditions at the Soda Springs Plant, Soda Springs, Idaho, January 6, 2006.

Golder 2006b, Work Plan for Drilling and Monitoring Well Installation, Monsanto Soda Springs Plant, August 3, 2006.

List of Figures

FIGURES

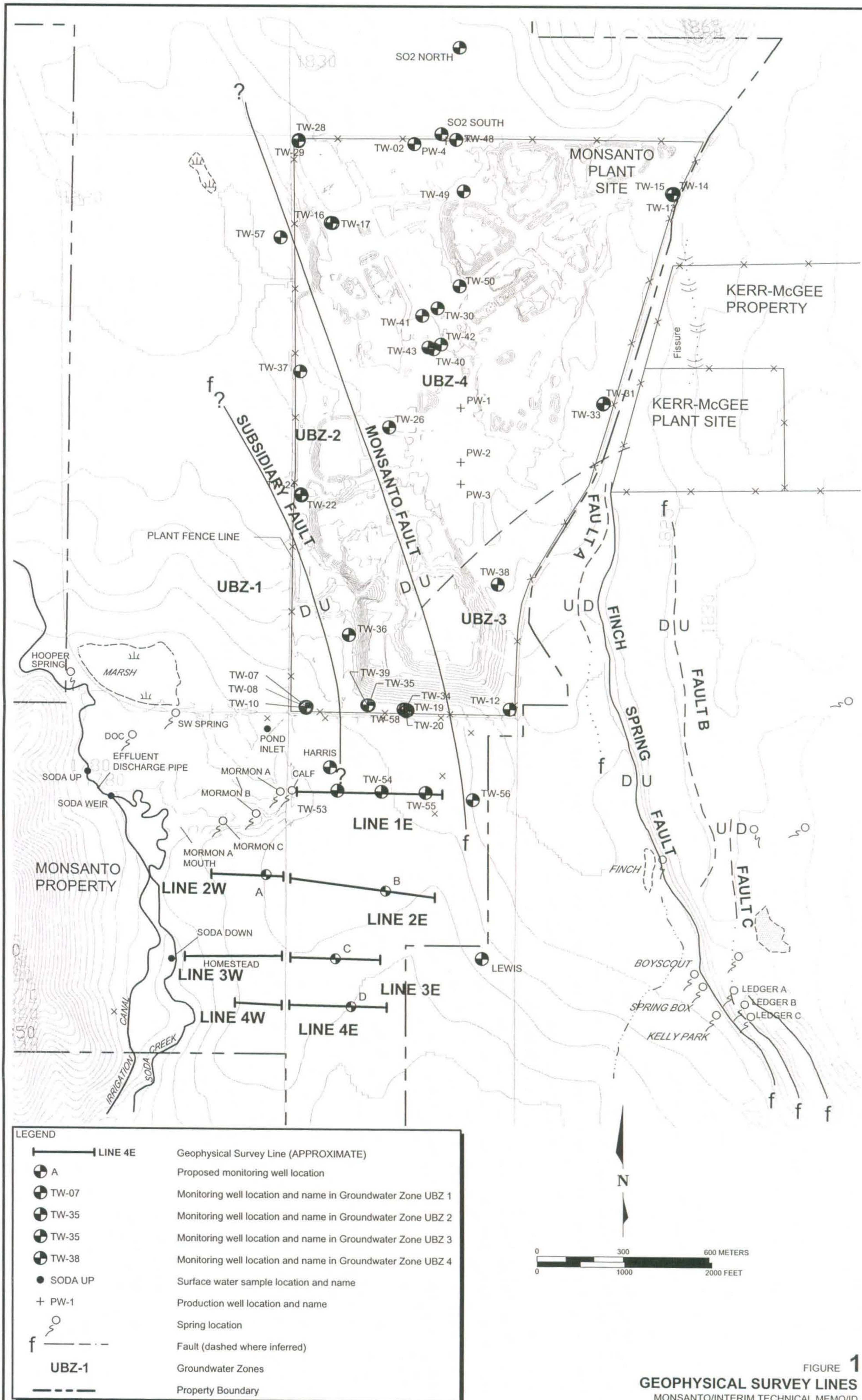

FIGURE 1

GEOPHYSICAL SURVEY LINES

MONSANTO/INTERIM TECHNICAL MEMO/ID

9131101605F18.dwg | Layout: FIGURE 1 | Modified: 10/06/2006, 10:28 | Plotted: 10/06/2006, 10:30

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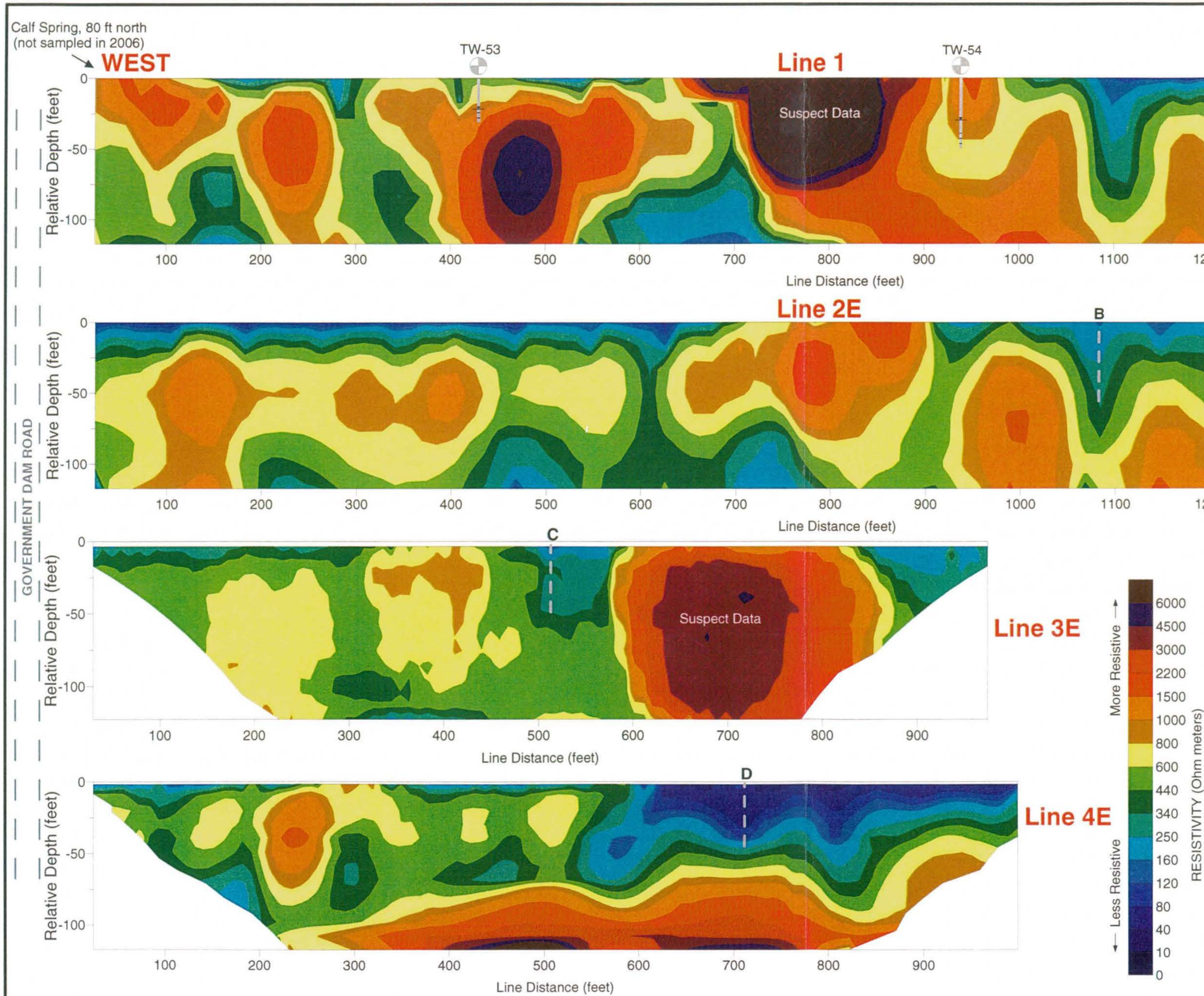


Notes:
1. Geophysical data collected August 2006
2. Figure 1 shows location of geophysical transects
3. ERI data processed using RES2DINV software
4. Vertical exaggeration = 1.5

PROJECT
MONTANTO SODA SPRINGS PLANT
SODA SPRINGS, ID

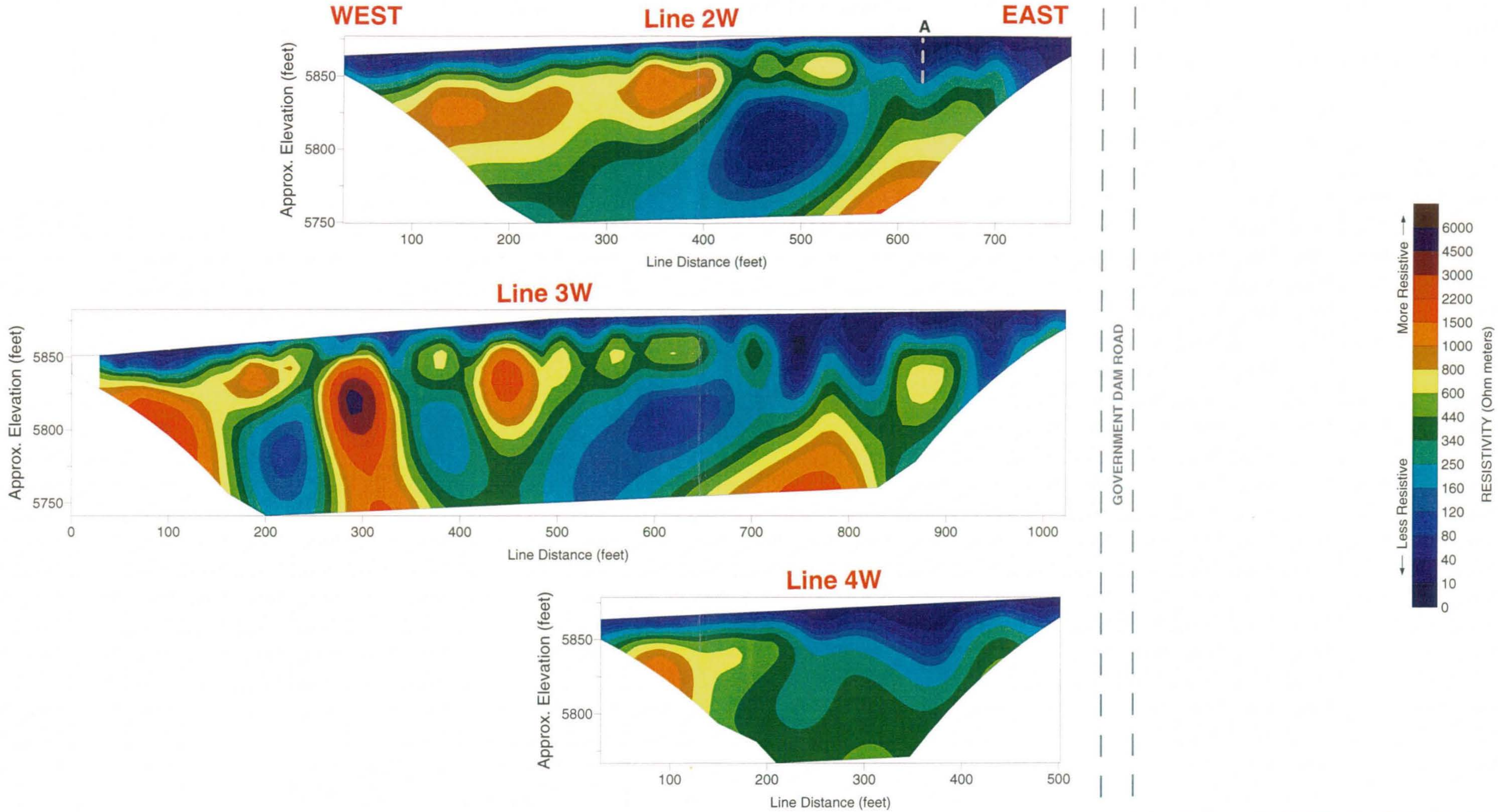
TITLE
ERI DATA AND INTERPRETATION
LINES EAST OF GOVERNMENT DAM ROAD

Golder Associates

PROJECT No. 913-1101.605			FILE No. --
DESIGN	PEF	06SEPT06	SCALE AS SHOWN REV.
CADD	PEF	15SEPT06	
CHECK	--		
REVIEW	--		

FIGURE 2

REVISION DATE: 09/15/06 BY: PEF SURFER FILE: 913-1101-605 FIGURE 2.srf



Notes:
1. Geophysical data collected August 2006.
2. Figure 1 shows location of geophysical transects.
3. ERI data processed using RES2DINV software.
4. Vertical Exaggeration = 1.5

PROJECT	MONTANTO SODA SPRINGS PLANT SODA SPRINGS, ID			
TITLE	ERI DATA AND INTERPRETATION LINES WEST OF GOVERNMENT DAM ROAD			
Golder Associates	PROJECT No. 913-1101.605			FILE No. --
	DESIGN	PEF	06SEPT06	SCALE AS SHOWN REV.
	CADD	PEF	15SEPT06	FIGURE 3
	CHECK	--		
	REVIEW	--		

REVISION DATE: 09/15/06 BY: PEF SURFER FILE: 913-1101-605 FIGURE 3.srf